e 9

13.

THE RÖNTGENOGRAPHIC DIAGNOSIS OF GALL-STONES AND CHOLECYSTITIS

By LEWIS GREGORY COLE, M.D., New York City
Professor of Radiology, Cornell University Medical College

COLLEGE OF SURGEONS OF ENGLAND
-4 DEC 14
LIBRARY

Reprint from
SURGERY, GYNECOLOGY AND OBSTETRICS
February, 1914, pages 218-227

AL COLL ... OF ENGLAND
-4 DEC 1
LIBRARY

THE RÖNTGENOGRAPHIC DIAGNOSIS OF GALL-STONES AND CHOLECYSTITIS[1]

By LEWIS GREGORY COLE, M. D., New York City
Professor of Radiology, Cornell University Medical College

THE röntgenographic diagnosis of gall-stones and cholecystitis is a subject that has interested röntgenologists and diagnosticians since the earliest use of the X-rays. It seemed reasonable that the röntgenographic method of detecting renal calculi would likewise reveal biliary calculi. But repeated failures led most of us to abandon hope, and for a long time not even to attempt the examination. With the increasing number of cases examined, and the use of an intensifying screen and soft tube, gall-stones were occasionally detected. This led me to the routine examination for gall-stones in all cases presenting symptoms referable to the right hypochondrium. The number of positive diagnoses which I have been able to make proves that the examination is justified; but a negative diagnosis should never be made where there is no evidence of a calculus.

Several observers have reported individual cases where gall-stones have been detected. Three cases were reported by Pfahler in 1911.[2] In 1913 Thurston Holland reported three cases, and called attention to the necessity for differentiating right renal calculi from biliary calculi.[3] This point alone justifies careful consideration of the subject. Gall-stones and cholecystitis have been observed röntgenographically in 20 out of 500 cases examined for gastro-intestinal lesions, and I believe that the systematic search for them by the method described in this article will reveal them in a much larger percentage of the cases examined. Before studying the röntgenographic indications of gall-stones and gall-bladder infection, the anatomy of this region should be noted. There are three possible locations for stones, viz., in the gall-bladder, the cystic duct, and the common duct. But such considerations, and also the frequency with which infection occurs with or without calculi, are questions not within the scope of this communication.

INDIRECT EVIDENCE OF BILIARY CALCULI

The röntgenographic indications of gall-stones are direct or indirect. Direct evidence consists of a characteristic localized area of increased density, corresponding in size and shape with a calculus. Indirect evidence is afforded by the distortion of the adjacent hollow viscera by adhesions from an accompanying cholecystitis (Figs. 1 to 6). The indirect evidence will be considered first because of its greater importance. Moynihan states that it is now a matter of general acceptance that gall-stones are caused by infection.[4] If this is true, the indirect evidence is more valuable than the direct evidence, and indeed my experience has borne out this theory. In 30 per cent of the cases the lesion was detected solely by indirect evidence, and in 60 per cent of the cases the indirect evidence was a most important factor. I believe that the deformity of the cap and pars pylorica or the kinking and constriction of the hepatic flexure are stronger röntgenologic indications for surgical procedure than the presence of a calculus in the gall-bladder, without evidence of adhesions involving the hollow viscera. In such cases it is immaterial whether the infection is due to gall-stones, typhoid, or some unknown cause, or whether it has been of sufficiently long standing to allow the formation of calculi. In view of the numerous post-mortem discoveries of gall-stones, which did not cause symptoms sufficiently severe to justify surgical interference, it is obvious that the important point to determine in cases of unimpacted calculi is whether the stones are associated with cholecystitis extensive enough to cause symptoms. The accompanying adhesions manifest themselves in an

---

[2] Fortschr. a. d. Geb. d. Röntgenstrahlen., 1911, xvi, 335.

[3] Arch. Röntg. Ray, Lond., 1913, March, p. 374.

[4] "An address on gall-stones." Brit. M. J., 1913, No. 2714, 8.

[1] Since presenting this paper before the Atlantic County Medical Society on May 9th, Dr. Case, of Battle Creek, has published an article on gall-stones. Arch. Röntg. Ray, 1913, September.

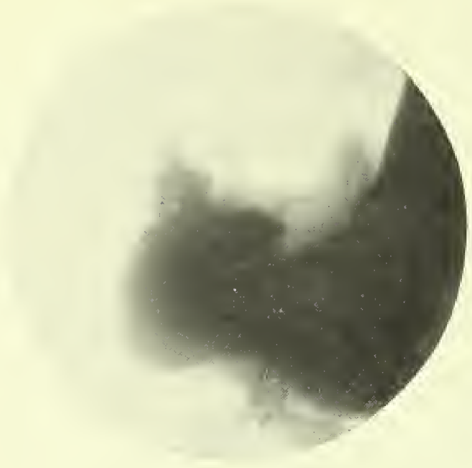


Fig. 1.

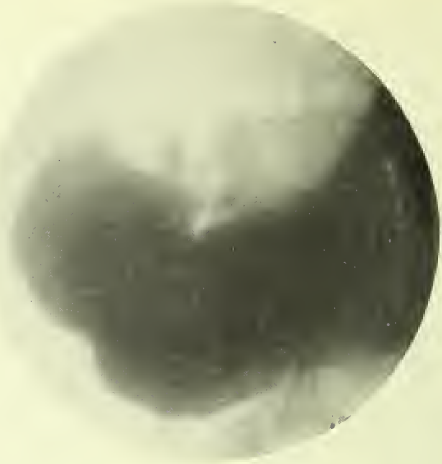


Fig. 2.

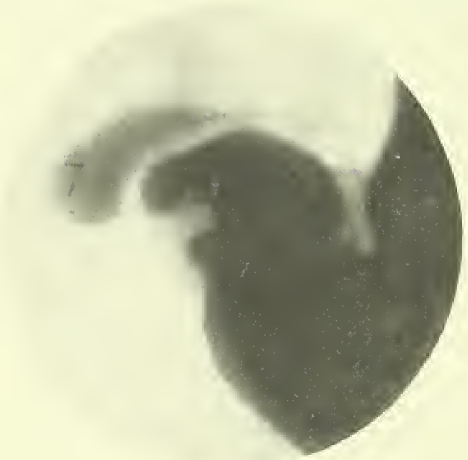


Fig. 3.

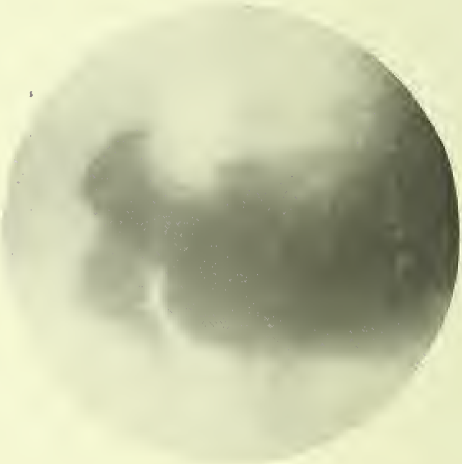


Fig. 4.

Fig. 1. Contraction of cap and pars pylorica by adhesions from cholecystitis with calculi invisible röntgenographically. Proven by surgery.

Fig. 3. Indentation in greater curvature, in which lay small, atrophic gall-bladder, containing calculus invisible röntgenographically. Proven by surgery.

Fig. 2. Absence of cap. Sphincter widened on lesser curvature. Cholecystitis with calculi invisible röntgenographically. Proven by surgery.

Fig. 4. Adhesions of cap and pars pylorica from cholecystitis. No calculus visible röntgenographically. Surgery imminent.

alteration of the lumen of the stomach, cap, or hepatic flexure of the colon.

DIRECT EVIDENCE OF BILIARY CALCULI

Regarding direct evidence of gall-stones, two things must be considered: first, the detection of the calculus, and second, its differentiation from a renal calculus or some other calcareous body in this region, especially a calcified costal cartilage. The possibility of detection depends upon the percentage of mineral salts in the stone, or surrounding a cholesterin nucleus, upon the thickness and density of the surrounding tissue, and the penetration of the X-ray tube. A soft tube, a very short exposure, and the use of an intensifying screen will give a wealth of detail impossible to obtain by ordinary methods. In-

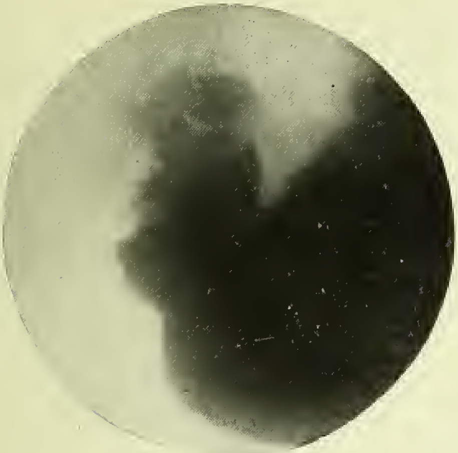


Fig. 5.

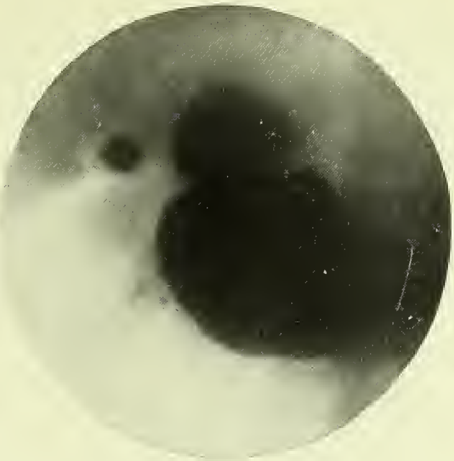


Fig. 6.

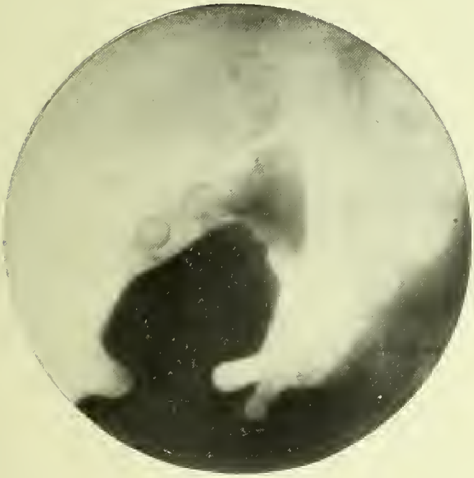


Fig. 7.

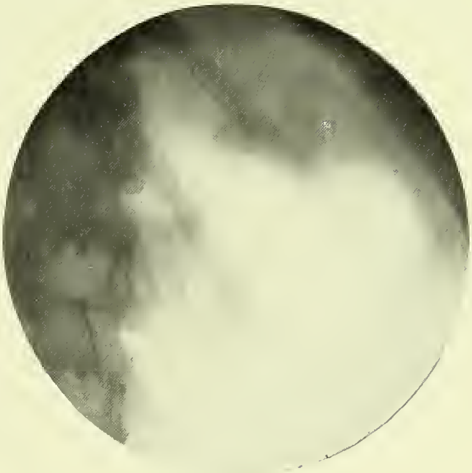


Fig 8

Fig. 5. Adhesions of cap, pyloric sphincter, and pars pylorica, from cholecystitis with a calculus visible röntgenographically (see Fig. 24). Proven by surgery.

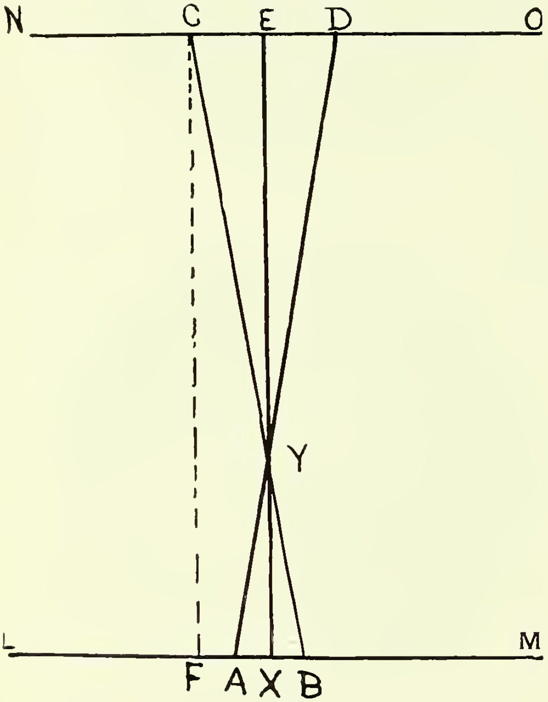
Fig. 7. Pressure on terminal wave and cap by four gall-stones. Anterior view. Proven by surgery.

Fig. 6. Adhesions of cap from cholecystitis with a calculus visible röntgenographically.

Fig. 8. Same case as Fig. 7. Posterior view.

testinal content is often thus accentuated, and must not be mistaken for gall-stones. I have not found that the twisted position of the patient, claimed by Pfahler as an essential to the diagnosis of gall-stones, is of any particular advantage.

In some instances the calculus is shown so clearly that there is absolutely no doubt of its presence. In other cases it is so indistinct (Fig. 22) that it can be discovered only by making several röntgenograms, superimposing two or three of them, and examining them carefully against the sky. A stereoscopic study of two röntgenograms made with the tube in the same position or at slightly different angles sometimes aids very materially in the detection and interpretation of doubtful shadows. Occasionally an accumulation of gas, or air artificially injected into the colon, will accentuate the stone in a remarkable manner. The organs surrounding it are relatively dense to the X-rays. There are stones which are no more opaque to the rays than the tissue which surrounds them, and there are others which are as opaque as the densest renal calculus. Between these two extremes are stones of all degrees of density. The technique above described will enable one to detect a relatively large percentage of biliary calculi.



Differentiation between biliary and renal calculi. The differential diagnosis of biliary calculi from right renal calculi is of great importance, and should be carefully made in every case presenting a stone in this region. The following points will aid in identification:

First. Biliary calculi show more distinctly and appear smaller when the plate is placed on the abdomen than when the plate is placed on the back. The opposite is true of renal calculi. When the biliary calculi is well back in the cystic duct, this variation of size is not so great as when it is in the gall-bladder. In such cases it is wise to place a small triangular marker on the abdominal wall and make two exposures, either on the same plate or on different plates, shifting the tube five inches between the exposures. Where two plates are used, match the shadows of the lead marker and measure the distance between the two shadows of the gall-stone. In order to determine with accuracy whether the shadow is nearer the anterior or posterior wall of the abdomen, repeat the above process with the plate posterior, and compare the distance between the shadows.

To determine distance of calculus from abdominal wall. By measuring the distances of the tube from the plate, and how far the tube is shifted between the exposures, the old principle of localizing foreign bodies described may be applied to find the distance of the calculus from the anterior abdominal wall.

Let NO = plane of the two positions of the tube.
C and D = two positions of the tube.
$CD = 5''$, distance between the positions of the tube.
LM = plate, parallel to plane NO.
X = shadow of marker on plate.
A = shadow of stone when tube is at D.
B = shadow of stone when tube is at C.
$EX = 20''$.

To find XY:—

By measurement AB is found to be $1''$.
$\therefore AX = \frac{1}{2}''$.
$CD = 5''$.
$\therefore DE\ 2\frac{1}{2}''$.

Lay off FX equal to EC.

$\triangle$ BFC and $\triangle$ BXY are right-angled $\triangle$'s, and have a common acute $<$ BCF.

The sides of right-angled triangles having a common acute angle have the same ratio.

$\therefore$ FB : FC :: XB : XY, or $3'' : 20'' :: \frac{1}{2}'' : XY$
$XY = 3\frac{1}{3}''$.

Q. E. D.

Second. The second differential point is the ring-like shadow cast by a biliary calculus when there is a calcareous coating to a cholesterin nucleus. Renal calculi seldom if ever have this appearance.

Third. When three or more biliary calculi are present they are likely to have faceted surfaces, which are readily recognized röntgenographically. If more than one renal calculus is present one is usually larger than the others, and the group frequently has the appearance of a large, branching phosphatic calculus.

Fourth. Moving the tube from side to side alters the relation of a biliary calculus to the kidney, but it does not alter the relation of a renal calculus to the kidney.

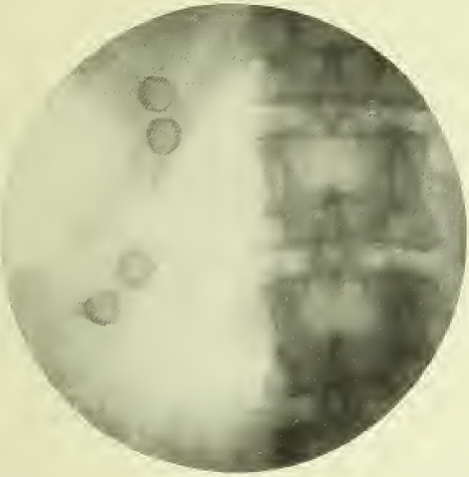


Fig. 9.

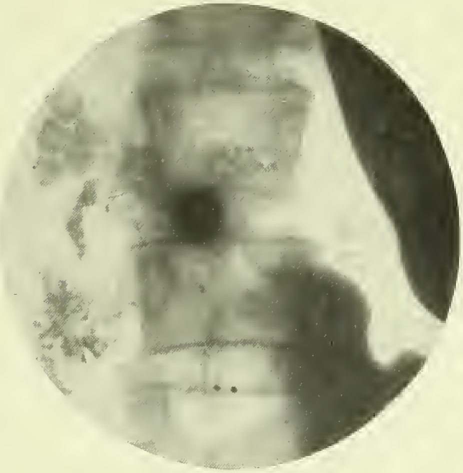


Fig. 10.

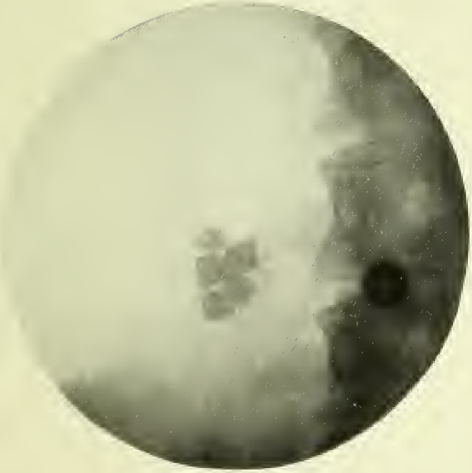


Fig. 11.

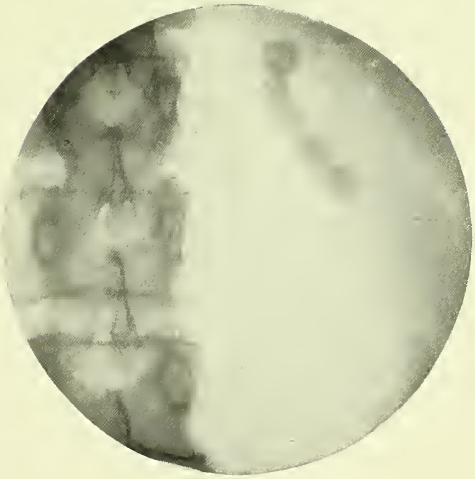


Fig. 12

Fig. 9. Same case as Fig. 7 five days afterwards. Showing change in relative position of stones. Anterior view.

Fig. 10. Adhesions of cap and pars pylorica from cholecystitis with five calculi. Anterior view.

Fig. 11. Same case as Fig. 10. Anterior view.

Fig. 12. Same case as Fig. 10. Posterior view.

Differentiation from duodenal ulcer. Adhesions from cholecystitis so closely resemble adhesions and cicatricial contraction from prepyloric or post-pyloric (duodenal) ulcers that it is sometimes difficult to differentiate between them. But if the lesion is sufficiently extensive to indicate surgical interference, the differentiation is of more scientific interest than practical value. The points of differentiation between these conditions are as follows:

"Gall-bladder infection is usually more extensive. It involves the greater curvature and draws the stomach to the right, causing an angulation of the cap. The cap may be involved in the adhesions, but not more so than the pyloric end of the stomach. There is no evidence of a localized area of induration of the cap, and obstruction of its lumen is not as frequent as in cases of duodenal ulcer."

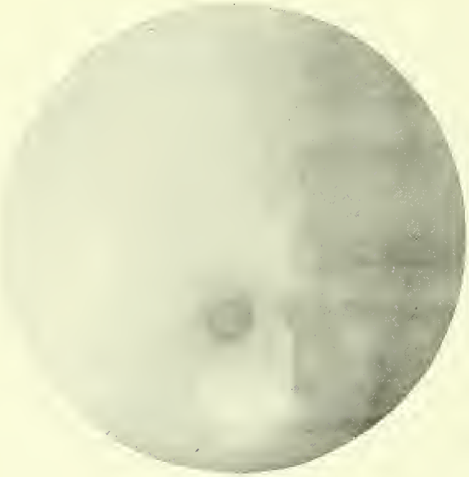


Fig. 13

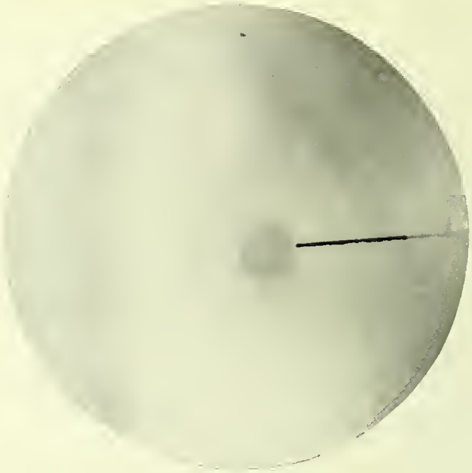


Fig. 14.

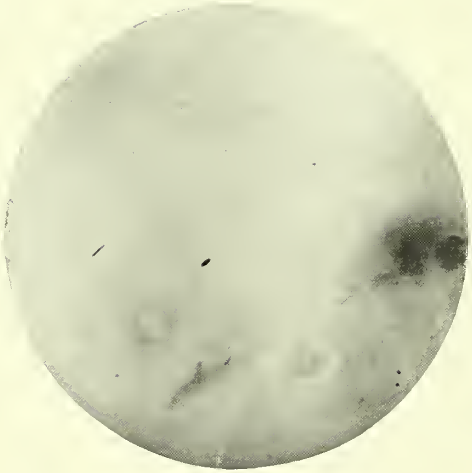


Fig. 15.

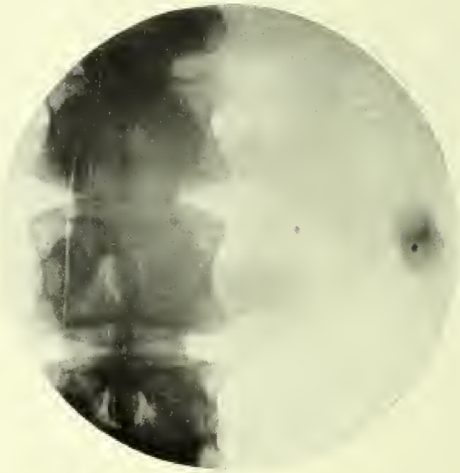


Fig. 16.

Fig. 13. Gall-stone, more dense near periphery than in center.

Fig. 15. Ring-like appearance of gall-stone, having center of cholesterin in a calcareous shell.

Fig. 14. Gall-stone, more dense near periphery than in center.

Fig. 16. Gall-stone, unusually dense to X-rays.

Case 1. March 19, 1912. This is the most interesting of all the cases. The patient had typical symptoms of renal calculus, except blood in the urine, and was referred for an examination of the kidneys. The röntgenograms showed the region in question with sufficient distinctness for a negative diagnosis of renal, ureteral, and vesical calculus, and I advised a gastric examination. This revealed a permanently contracted cap and adhesions involving the extreme pyloric end of the stomach. I was unable to decide whether these adhesions were caused by duodenal ulcer or gall-bladder infection, but stated that surgical interference was justifiable, solely on the röntgenographic findings. Dr. Brewer, who operated, was rewarded for his confidence in the röntgenologic diagnosis by finding a cholecystitis with a number of small calculi not shown in the radiograph (Fig. 1).

Case 2. December 21, 1910. There was a definite indirect evidence of adhesions involving the cap and pyloric end of the stomach, but there was no direct evidence of gall-stones. Some doubt existed as to whether the adhesions were caused by ulcer or gall-bladder infection, but there was no question as to

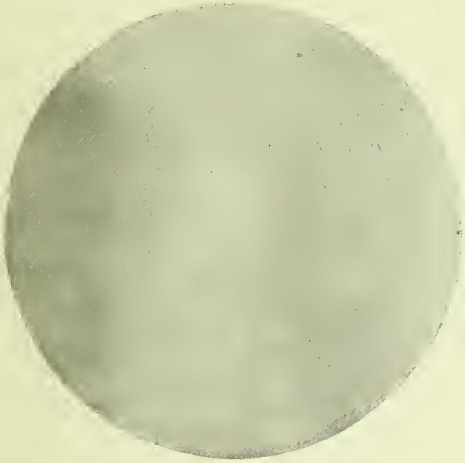


Fig. 17.

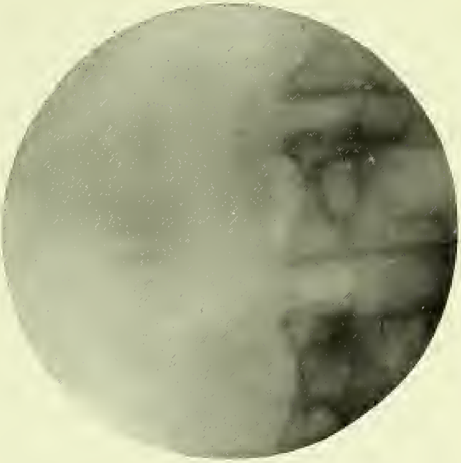


Fig. 18.

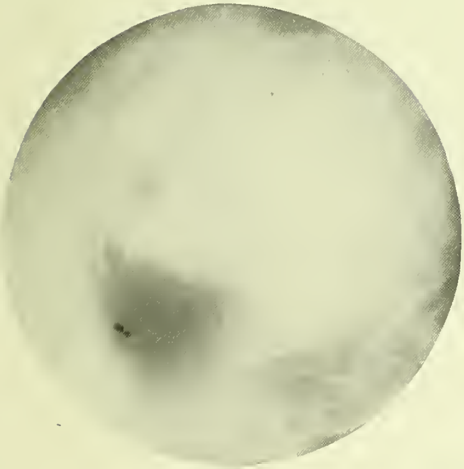


Fig. 19.

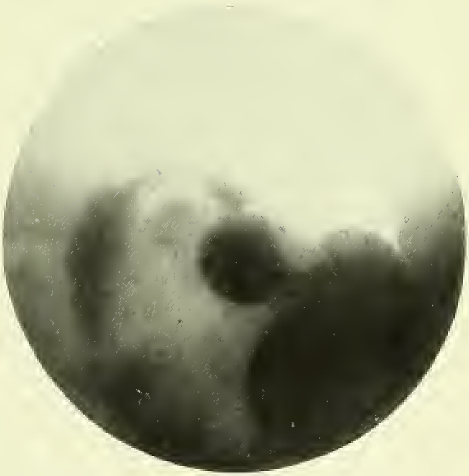


Fig. 20.

Fig. 17. Two small gall-stones, accentuated by an overlying accumulation of gas in colon.

Fig. 18. Large gall-stone, one inch in diameter.

Fig. 19. Cap so contracted by cholecystitis that only its base on left side is visible. Calculus in close proximity. Anterior view.

Fig. 20. Same case as Fig. 19. Lateral view showing how descending duodenum encircles calculus.

the advisability of surgical procedure. The lesion was found to be a cholecystitis with gall-stones, which were not shown röntgenographically (Fig. 2).

Case 3. January 23, 1912. In this case there was no direct evidence of gall-stones, but there was a constant deep indentation on the greater curvature near the pylorus, resembling a small hour-glass stomach (Fig. 3). I thought that this lesion was caused by an old ulcer, and advised surgical procedure, which revealed a small calculus about the size of an almond in a contracted gall-bladder adherent to the gastric wall. This case has been frequently quoted as one in which I made an erroneous diagnosis. As a matter of fact, I recognized the location and extent of the lesion and stated that surgical procedure was indicated; and I maintain that recognition of the cause of the lesion is of more scientific interest than practical value.

Case 4. January 10, 1913. The patient had had a perfectly typical attack of cholecystitis, with temperature, local tenderness, and a marked degree of jaundice. The röntgenograms showed a contracted cap and irregularities of the sphincter and lesser curvature of the pars pylorica, which constitute definite indirect evidence of adhesions involving this region (Fig. 4). The patient recovered from this

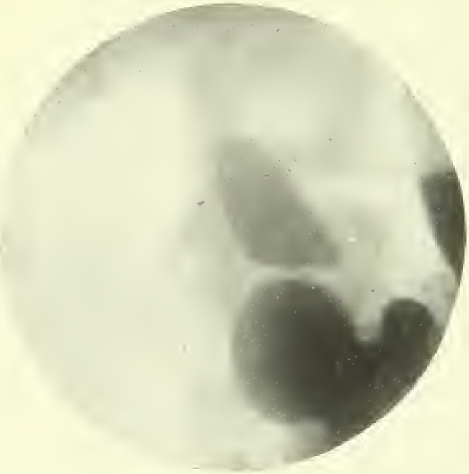


Fig. 21.

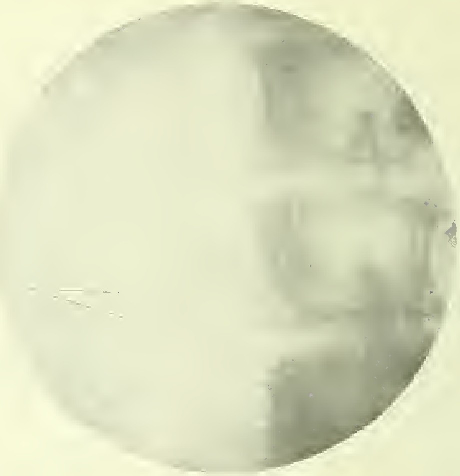
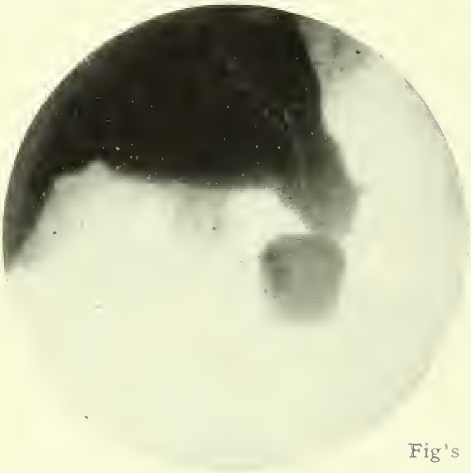


Fig. 22.



Fig's 23 and 24
are upside down.

Fig. 23.

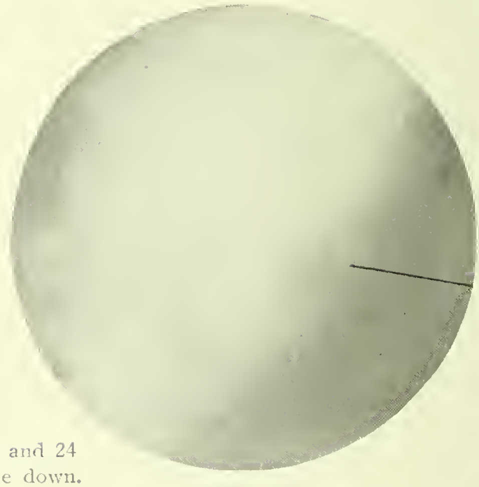


Fig. 24.

Fig. 21. Calcareous plaque in under surface of liver, diagnosed röntgenographically as a gall-stone. Proven by surgery.

Fig. 23. Gall-stone. No evidence of accompanying cholecystitis.

Fig. 22. Two indistinctly defined gall-stones. Proven by surgery.

Fig. 24. Large, faintly outlined gall-stone. Proven by surgery. For indirect evidence in this case see Fig. 5.

attack, and has not as yet consented to surgical procedure.

Case 5. March 19, 1912. Patient shows both direct and indirect evidence of gall-stones, although the indirect is of more diagnostic importance than the direct evidence. An indistinct shadow of a large biliary calculus was present in all the radiographs (Figs. 5 and 24), but the adhesions caused by the cholecystitis were so extensive that they made me suspicious of carcinoma. The following is a quotation from the röntgenologic report.

"The absence of the duodenum, the contracted cap, the irregular worm-eaten appearance at the pylorus, and the absence of the pyloric sphincter indicate a lesion in this region which calls for surgical procedure. This lesion is probably adhesions from gall-bladder infection, probably with a calculus; but considering the irregular worm-eaten appearance of the pyloric end of the stomach, I do not feel justified in eliminating carcinomatous degeneration."

Six months later a note received from the patient's husband stated that she had not consulted a surgeon: "By following a strict diet for two months she is greatly improved in health; while she is not considered permanently well, there is no longer any particular disturbance of the digestion or stomach."

Three months after this her physician wrote me that the patient had been seized with a sudden attack similar to the two previous attacks, which suggested gall-stone trouble very strongly. She was at once operated upon and a large gall-stone was found in the intestinal lumen, having worked through the adhesions from the gall-bladder and, at the time of this last attack, caused perforation of the bowel and acute septic peritonitis, resulting in the patient's death.

Case 6. January 11, 1912. Both direct and indirect evidence of a biliary calculus were present, the stone resembling the one shown in Case 9; but it lies so far back in the cystic duct that there is not so much variation between its size in the anterior and posterior röntgenograms as in that case. As the characteristic ring-like appearance and the faceted surfaces were wanting, it was difficult to differentiate it from renal calculus. There were, however, indirect evidences of an accompanying cholecystitis with adhesions involving the cap and pylorus. The distended gall-bladder shows distinctly. The case was studied for a year, making two or three sets of röntgenograms, and during that time the adhesions involving the cap increased and caused a gastric retention. Surgical procedure revealed a gall-bladder corresponding in size and shape with the röntgenographic findings, the gall-stones, and the accompanying cholecystitis with adhesions (Fig. 6).

Case 7. January 25, 1912. This case illustrates direct röntgenographic evidence of four gall-stones having the characteristic ring-like appearance. They show much clearer and appear smaller in the anterior than in the posterior röntgenogram. The clinical diagnosis prior to the röntgenographic examination was duodenal ulcer. Surgical procedure revealed a carcinoma of the appendix in addition to the gall-stones. Note the absence of adhesions, as evidenced by a normal cap and pyloric sphincter. By making a large series of röntgenograms we were able to obtain stereoscopic plates showing the manner in which the chain of calculi wrapped around the head of the pylorus (Figs. 7, 8 and 9).

Case 8. January 13, 1911. A perfectly characteristic group of five calculi with faceted surfaces is shown in this case. The relation of these calculi to the junction of the cap and descending duodenum and their variation in size in the anterior and posterior radiographs are the pathognomonic radiographic indications of gall-stones (Figs. 10, 11 and 12). So far as I know this woman has not been operated, but there is no doubt of the diagnosis in this particular case.

Case 9. January 11, 1910. The variation in size of a calculus in the anterior and posterior röntgenograms are shown in Figs. 13 and 14. This calculus did not have the characteristic ring-like appearance or faceted surface, but shifting of the tube between exposures altered its relation to the kidney. The patient was an unfavorable surgical risk, and no operation was performed, and no examination made for indirect evidence.

Case 10. July 1, 1911. The characteristic ring-like appearance of a calculus, which is much more distinct in the anterior than in the posterior röntgenogram (Fig. 15), was present in this case.

Case 11. December 11, 1905. This patient was examined for renal calculus. A distinct shadow was shown, slightly below the normal position of the kidney (Fig. 16). Operation failed to reveal a renal calculus, but a biliary calculus corresponding in size and shape with the röntgenographic finding was found.

Case 12. May 13, 1913. The clinical history was one of acute attacks of pain, which had been diagnosed both as gall-stone and ptomaine poisoning. The indirect evidence showed a persistent contraction of the cap and an irregularity of the pyloric sphincter, believed to be either a spasm or adhesions. Subsequent plates, made for direct evidence, showed two clear-cut, well-defined shadows having the appearance of diplococci. They were visible in several plates, but happened to be very much accentuated in one of the plates presenting an accumulation of gas in the overlying gut (Fig. 17).

Case 13. May 22, 1913. For two years the patient had had occasional attacks of severe pain and upward pressure in epigastrium, lasting for six and seven hours and leaving him sore and weak. He had lost thirty pounds in about a year. The röntgenograms showed direct evidence of a large calcified body anterior to the kidney and directly in the position of the gall-bladder (Fig. 18). The indirect evidence was pylorospasm and contraction of the cap, with a possibility of some adhesions. This is a recent case, and the patient is waiting until the summer is over before submitting himself to surgery.

Case 14. May 15, 1913. The röntgenograms (Figs. 19 and 20) show both direct and indirect evidence. The cap is contracted and the pyloric sphincter irregular. Röntgenograms made in the lateral direction show that the descending duodenum encircles a gall-stone.

Case 15. October 4, 1912. The direct and indirect evidence were at variance in this case (Fig. 21). The direct evidence showed a calculus, which I interpreted as a gall-stone after a most careful examination, including an application of all of the methods previously described. The indirect evidence showed no adhesions, as there was a perfectly normal stomach, pylorus, and cap, freely movable. Surgical procedure failed to reveal a biliary calculus, but there was a calculus in the under surface of the liver in close proximity to the gall-bladder, which was involved in slight adhesions, not, however, extending to the capsule in the liver. A thick band of the omentum was attached to the stump of an appendix previously removed.

Case 16. February 26, 1913. The plates showed such slight ring-like shadows that they could be perceived only by viewing the plate against the sky, and it was difficult to differentiate them from calcified costal cartilages (Fig. 22). We traced the outlines of two complete and several incomplete rings, and assumed that there were three or four calculi. Surgical procedure revealed only two calculi and a mass of thick tarry bile.

CASE 17. February 15, 1913, shows a calculus in exactly the proper relation to the duodenum and hepatic flexure for a gall-stone; but the patient was not a good surgical risk, and the symptoms were not sufficiently severe to indicate surgical procedure (Fig. 23).

CASE 18. March 24, 1911. A calcareous body was present in a series of röntgenograms. The clinical symptoms were those of gall-stones. Surgical procedure revealed a gall-stone; but there was also a calcified gland palpable in the field of operation, so it is impossible to state whether or not this really was a gall-stone.

CASE 19. February 26, 1912. The findings in this instance were almost identical with those of Case 18. Patient has not yet been operated on.

CASE 20. October 6, 1908. The plate illustrating this case was loaned to the surgeon and lost track of. The diagnosis was that of a gall-stone a little larger than a pea, one-half inch to the outer side of the median line, between the eleventh and twelfth ribs, behind and opposite the end of the sixth rib in front. The surgical findings confirmed the diagnosis.

Indirect evidence of gall-stones, or rather of an accompanying cholecystitis, as presented by adhesions involving the stomach, cap, duodenum, or hepatic flexure, is of more clinical value than the detection of the gall-stones themselves, because the adhesions represent an accompanying infection, requiring surgical intervention, while a gall-stone without infection may remain in the gall-bladder indefinitely without causing symptoms.

In conclusion, I would state that gall-stones may be detected sufficiently often to justify a röntgenographic search for them, but the absence of any direct evidence does not justify one in making a negative diagnosis, and should not prevent surgical intervention provided it is clearly indicated by the history.

Above all, I plea for a differential diagnosis between right renal calculi and gall-stones.